

WHAT IS CLAIMED IS:

1. A level indicator which is intimately affixed to the outside surface of the outside wall of a container for use in determining the level of the interface between a liquid and the void volume above said liquid within a container;

wherein said liquid has a faster rate of heat transfer than said void volume above it within a container;

said level indicator being in the form of an elongated strip, vertically extending along the height of a container,

wherein said level indicator conforms to the contour of the outside surface of the outside wall of a container such that said level indicator is in intimate heat transfer relationship with the outside wall of a container;

wherein said level indicator includes a thermochromic leucodye ink layer, said thermochromic leucodye ink layer having at least one leucodye ink therein;

whereby when said level indicator is in a heat transfer relationship with a heat transfer-inducing agent, said at least one leucodye ink in said level indicator, in the region of the interface between the liquid and the void volume above it within the container and having an operating temperature range encompassing the temperature of the heat transfer-inducing agent, will exhibit a profound color change responsive to heat transfer between the heat transfer-inducing agent and the liquid so as to permit the level of the interface to be detected.

2. The level indicator of claim 1, wherein said thermochromic leucodye ink layer has at least two leucodye inks therein which are different from one another, and said at least two leucodye inks being arranged in at least two regions;

wherein each of said at least two regions of leucodye inks is arranged in an individual area, and each of said leucodye inks responds chromatically within a different operating temperature range; and

wherein said regions of said at least two leucodye inks are disposed in arrays thereof arranged along the length of said level indicator;

whereby when said level indicator is in a heat transfer relationship with a heat transfer-inducing agent, at least one of said at least two leucodye inks in said level indicator, in the region of the interface between the liquid and the void volume above it within the container and having an operating temperature range encompassing the temperature of the heat transfer-inducing agent, will exhibit a profound color change responsive to heat transfer between the heat transfer-inducing agent and the liquid so as to permit the level of the interface to be detected.

3. The level indicator of claim 1, wherein said level indicator vertically extends along the height of a container, at least in the region of the top portion of the container, and at least above the legal safe-fill level of said liquid within a container such that overfilling of said liquid in a container is detectable.

4. The level indicator of claim 1, further including a layer of base material which is intimately affixed to the outside wall of a container in such a manner that said layer of base material is in intimate heat transfer relationship with the outside wall of a container, and wherein said thermochromic leucodye ink layer overlies said layer of base material.

5. The level indicator of claim 4, wherein said layer of base material is applied to the outside wall of a container by an application method chosen from the group consisting of permanently securing said base material to the outside surface of

the outside wall of a container, and removably securing said base material to the outside surface of the outside wall of a container when said base material additionally has adhesive or magnetic properties so as to permit said level indicator to be repeatedly removed and reattached to the outside wall of a container.

6. The level indicator of claim 2, further including a layer of base material which is intimately affixed to the outside wall of a container in such a manner that said layer of base material is in intimate heat transfer relationship with the outside wall of a container, and wherein said thermochromic leucodye ink layer overlies said layer of base material;

wherein said layer of base material is applied to the outside wall of a container by an application method chosen from the group consisting of permanently securing said base material to the outside surface of the outside wall of a container, and removably securing said base material to the outside surface of the outside wall of a container when said base material additionally has adhesive or magnetic properties so as to permit said level indicator to be repeatedly removed and reattached to the outside wall of a container; and

wherein when said layer of base material is directly applied to the outside wall of a container, and said at least two leucodye inks have been applied to said base material by an application method chosen from the group consisting of painting, silk screening, offset lithography, flexography, gravure, stencilling, crayon transfer, pencil transfer, screening, and combinations thereof.

7. The level indicator of claim 4, wherein said base material has a series of indicia printed thereon, and wherein said indicia are vertically positioned along the length of said base material and at predetermined spaced-apart locations.

8. The level indicator of claim 2, further including a layer of base material which is intimately affixed to the outside wall of a container in such a manner that said layer of base material is in intimate heat transfer relationship with the outside wall of a container, and wherein said thermochromic leucodye ink layer overlies said layer of base material;

wherein said base material has a series of indicia printed thereon, and wherein said indicia are vertically positioned along the length of said base material and at predetermined spaced-apart locations; and

wherein said indicia on said base material remain invisible until such time when at least a portion of one of said at least two leucodye inks of said thermochromic leucodye ink layer becomes activated, and when activated, said portion of one of said at least two leucodye inks becomes translucent, so as to reveal at least one of said indicia printed on said base material.

9. The level indicator of claim 4, wherein said base material has light absorbing properties.

10. The level indicator of claim 2, wherein said thermochromic leucodye ink layer further includes a light absorbing background upon which said at least two regions of leucodye inks are arranged.

11. The level indicator of claim 2, wherein said at least two leucodye inks are directly applied to the outside surface of the outside wall of a container.

12. The level indicator of claim 11, wherein each of said at least two leucodye inks is directly applied to the outside surface of the outside wall of a container by an application method chosen from the group consisting of painting, silk screening,

offset lithography, flexography, gravure, stencilling, crayon transfer, pencil transfer, screening, and combinations thereof, and wherein each of said at least two leucodye inks is carried to the outside surface of the outside wall of a container during the application method by a transfer medium.

13. The level indicator of claim 12, wherein said transfer medium is chosen from the group of formulations consisting of solvent-based, water-based, plastisol, UV formulations, and combinations thereof.

14. The level indicator of claim 12, wherein at least a portion of the outside surface of the outside wall of a container which underlies said level indicator has been treated by an application method chosen from the group consisting of anodizing, anti-oxidizing, rust-proofing, and combinations thereof, so as to provide at least that portion of the outside surface of the outside wall with a light absorbing property, prior to the direct application of said level indicator to the outside surface of the outside wall of a container.

15. The level indicator of claim 1, wherein said level indicator is intimately affixed to the outside surface of the outside wall of a container chosen from the group of containers consisting of pressurized cylinders, open containers, sealed containers, cryogenic flasks, and opaque vessels, for determining the level of the interface between said liquid and said void volume above said liquid within a container to which said level indicator is intimately affixed.

16. The level indicator of claim 1, further including a protective clear lamina, wherein said protective clear lamina overlies said at least one leucodye ink.

17. The level indicator of claim 16, wherein said protective clear lamina is an ultraviolet filter.
18. The level indicator of claim 1, wherein said at least one leucodye ink has previously been combined with standard ink components.
19. The level indicator of claim 2, wherein said at least two leucodye inks in said array have overlapping temperature ranges.
20. The level indicator of claim 2, wherein said regions of leucodye inks are arranged on said outside surface of the outside wall of a container, are chosen from the group of arrays consisting of one of said regions of leucodye ink vertically positioned down the center of said level indicator and at least one other region diagonally positioned on each side of said vertically positioned region of said level indicator, all of said regions of leucodye inks vertically positioned upon said level indicator, and all of said regions of leucodye inks horizontally positioned upon said level indicator.
21. The level indicator of claim 2, wherein said at least two adjacent regions of leucodye inks are arranged to form a set, and wherein said set is disposed vertically along the length of said level indicator in a repeated manner.
22. The level indicator of claim 1, wherein said heat transfer-inducing agent is chosen from the group consisting of hot air, cold air, steam, hot liquid, cold liquid. ✓
23. A method of determining the level of the interface between a liquid and the void volume above said liquid within a container using a level indicator which is intimately affixed to the outside surface of the outside wall of a container;

wherein said liquid has a faster rate of heat transfer than said void volume above it within a container;

said level indicator being in the form of an elongated strip, vertically extending along the height of a container;

wherein said level indicator conforms to the contour of the outside surface of the outside wall of a container such that said level indicator is in intimate heat transfer relationship with the outside wall of a container;

wherein said level indicator includes a thermochromic leucodye ink layer, said thermochromic leucodye ink layer having at least one leucodye ink therein;

said method comprising the steps of:

(i) inducing heat transfer with said heat transfer-inducing agent between said level indicator and the liquid within a container; and

(ii) discerning visually a color change in said at least one region of said array of said level indicator;

wherein said region which responds chromatically to a temperature change is contiguous to the liquid within a container at the interface between the liquid and the void volume above it within a container;

wherein step (i) is achieved by selecting any one of the steps chosen from the group of steps consisting of:

(a) spraying a fluidic material onto the outer surface of said level indicator;

(b) wetting the outer surface of said level indicator with a moistened cloth or sponge;

(c) pouring a fluidic material down the outer surface of said level indicator;

(d) trickling a fluidic material down the outer surface of said level indicator; and

(e) applying an electrically energized source along the length of said of said level indicator.

24. The method of claim 23, wherein said fluidic material in any of steps (a) through (d) is a heat source, and wherein said fluidic material is at a temperature which is above the temperature of the liquid within the container so as to induce heat transfer from said fluidic material to the liquid within a container.

25. The method of claim 23, wherein said fluidic material in any of steps (a) through (d) is a heat sink; and wherein said fluidic material is at a temperature which is below the temperature of the liquid within a container so as to induce heat transfer to said fluid material from the liquid within a container.

The method of claim 23, wherein said thermochromic leucodye ink layer has at least two leucodye inks therein which are different from one another, and said at least two leucodye inks are arranged in at least two regions;

wherein each of said at least two regions of leucodye inks is arranged in an individual area, and each of said leucodye inks responds chromatically within a different operating temperature range; and

wherein said regions of said at least two leucodye inks are disposed in arrays thereof arranged along the length of said level indicator.

27. The method of claim 26, wherein said at least two adjacent regions are arranged to form a set; wherein said set comprises said at least two leucodye inks, and

wherein said set is disposed vertically along the length of said level indicator in a repeated manner.

28. The method of claim 27, wherein said plurality of sets are disposed in a repeated manner vertically along the length of said level indicator, and said method further comprises the step of:

(iii) estimating the level of the interface between the liquid and the void volume above the liquid within a container using said level indicator, wherein the estimated area falls between a level having a profound color change and a level having a faint color change.